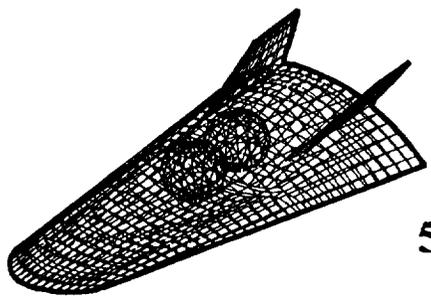


28-20
37552

FUSION PROPULSION AND POWER FOR FUTURE FLIGHT



**H. D. Froning, Jr.
Flight Unlimited
5450 Country Club Drive
Flagstaff, Arizona**

**NASA Langley Advanced Transportation Workshop
"Transportation Beyond 2000"**

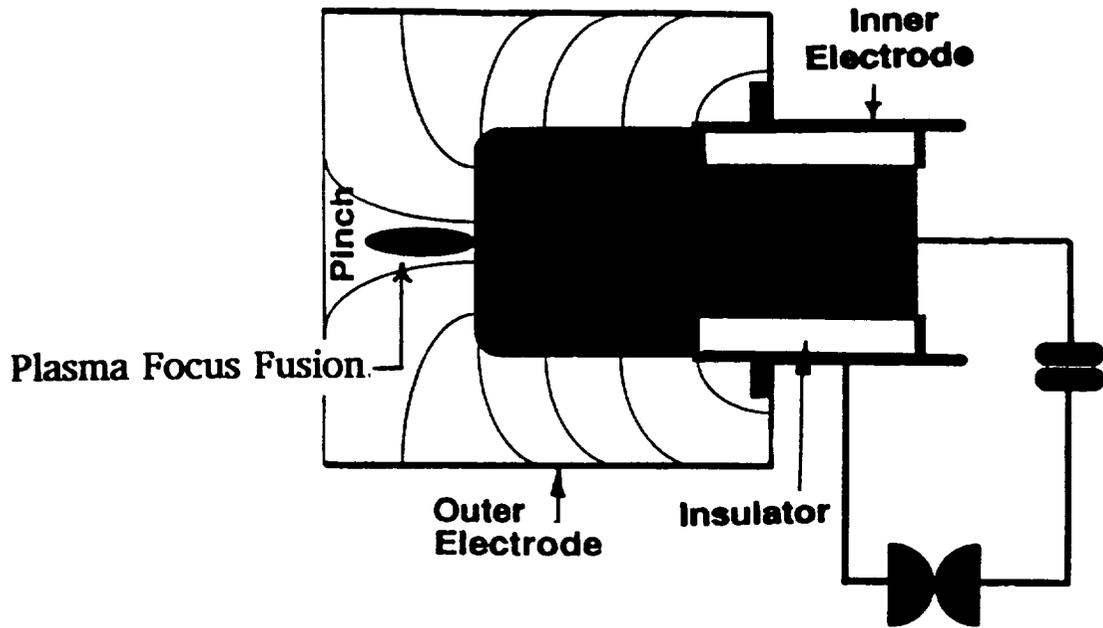
September 26-28, 1995

Flight Unlimited

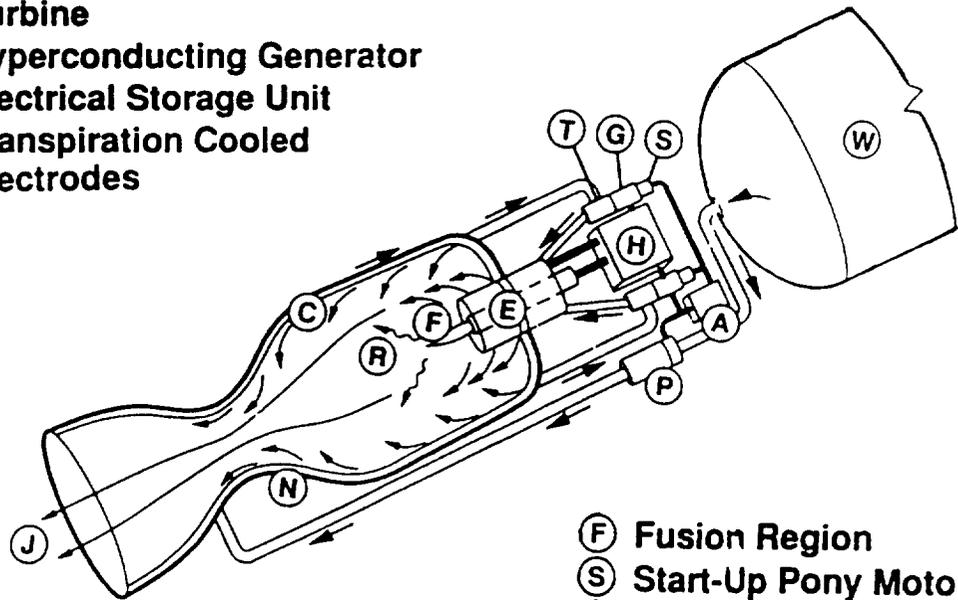
There are innovative magnetic and electric confinement fusion power and propulsion system designs with potential for:

- **Vacuum specific impulses of 1500-2000 seconds with rocket engine thrust/mass ratios of 5-10 g's**
- **Environmentally favorable exhaust emissions if aneutronic fusion propellants can be used**
- **A 2 to 3-fold reduction in the mass of hypersonic airliners and SSTO aerospace planes**
- **A 10 to 20 fold reduction in Mars expedition mass and cost (if propellant from planetary atmospheres is used)**

And feasibility or in-feasibility of these systems could be confirmed with a modest applied research and exploratory development cost

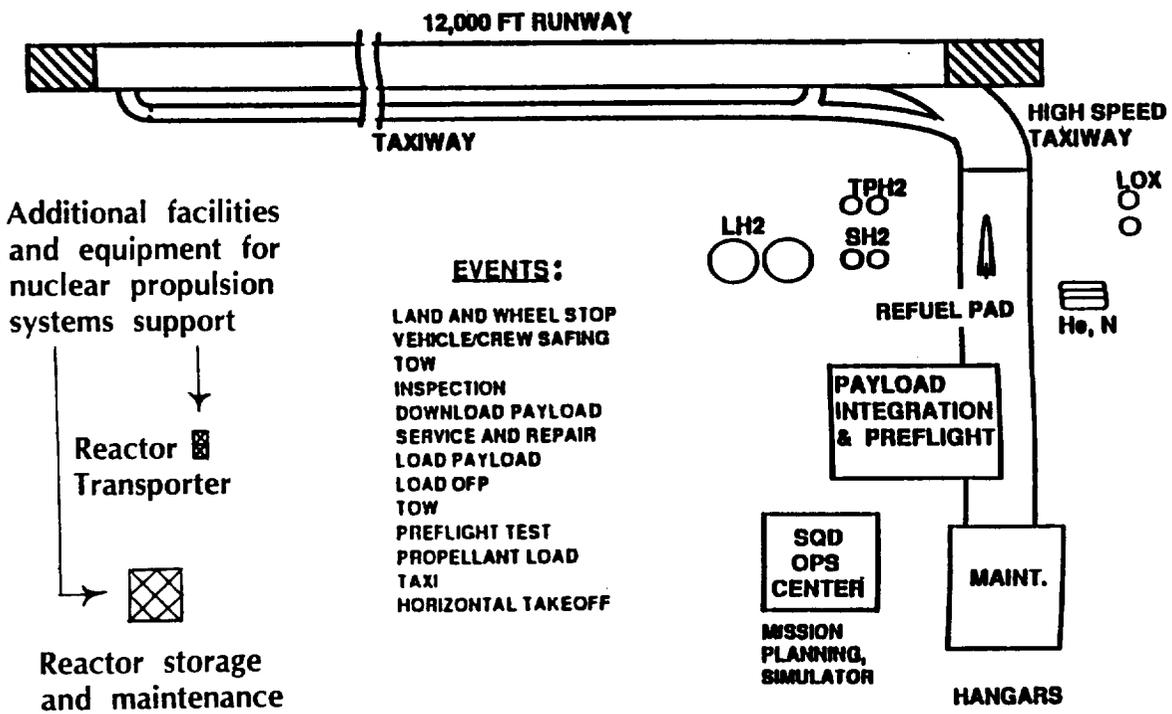
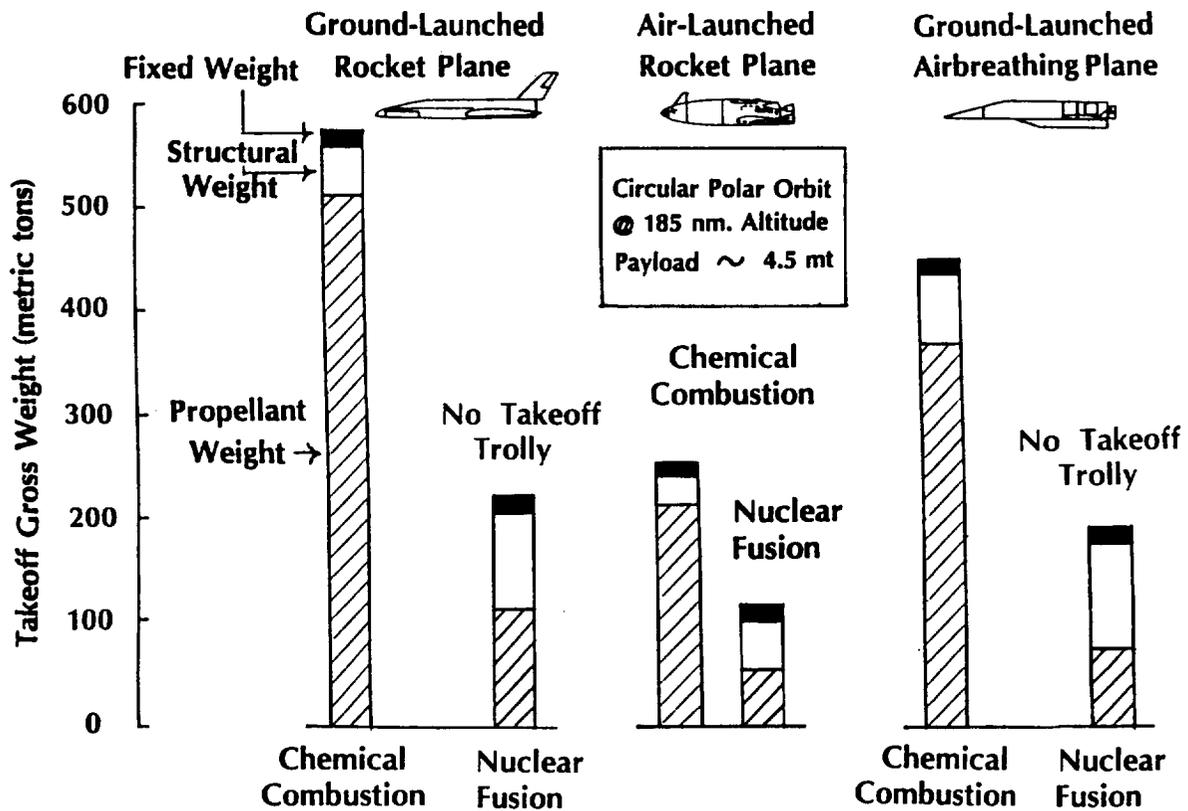


- Ⓜ Propellant Tank
- Ⓟ Propellant Pump
- Ⓐ Auxiliary Electrical Power Unit
- Ⓝ Transpiration Cooled Chamber
- Ⓣ Turbine
- ⓖ Hyperconducting Generator
- ⓗ Electrical Storage Unit
- Ⓔ Transpiration Cooled Electrodes



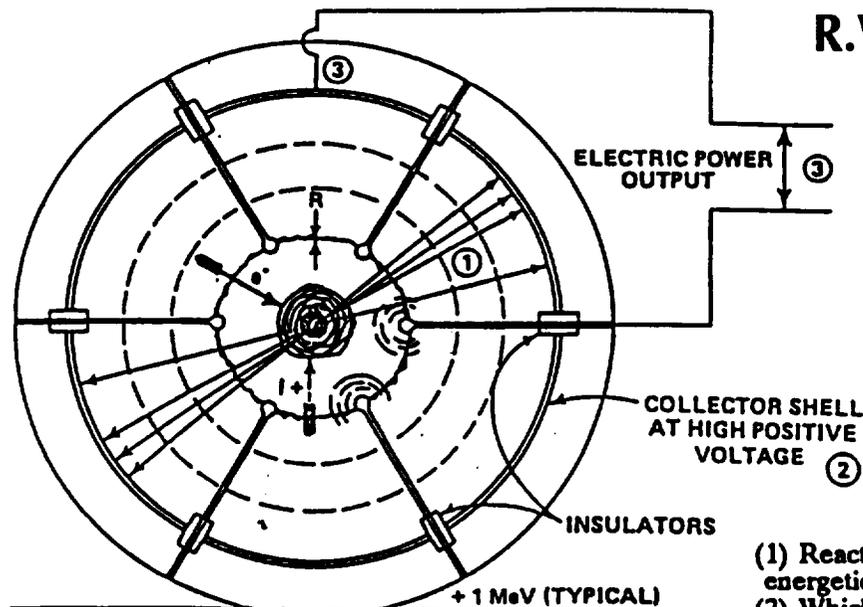
Plasma focus Engine

- ⓕ Fusion Region
- Ⓢ Start-Up Pony Motors
- Ⓡ Radiation to Propellant
- Ⓜ Propellant Jet

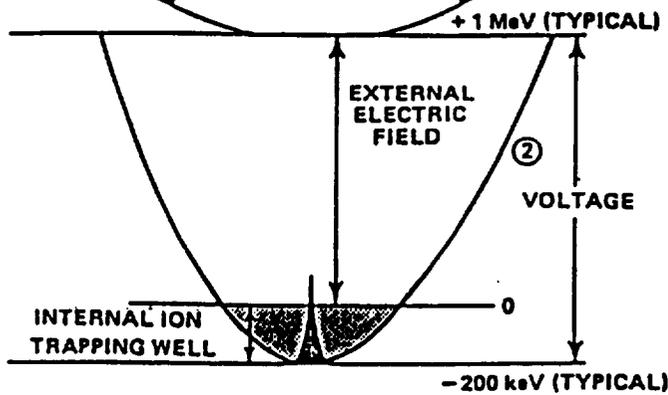


Facility, Operation, and Support

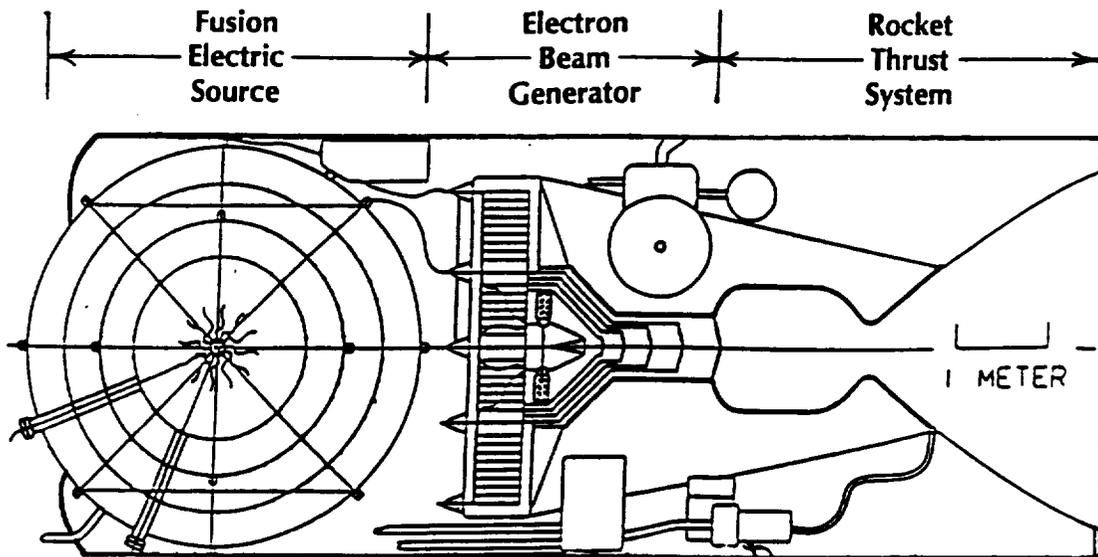
R.W. Bussard



- (1) Reaction products are energetic charged particles,
- (2) Which escape against spherically symmetric radial voltage gradient,
- (3) To yield radiation-free direct electric power output

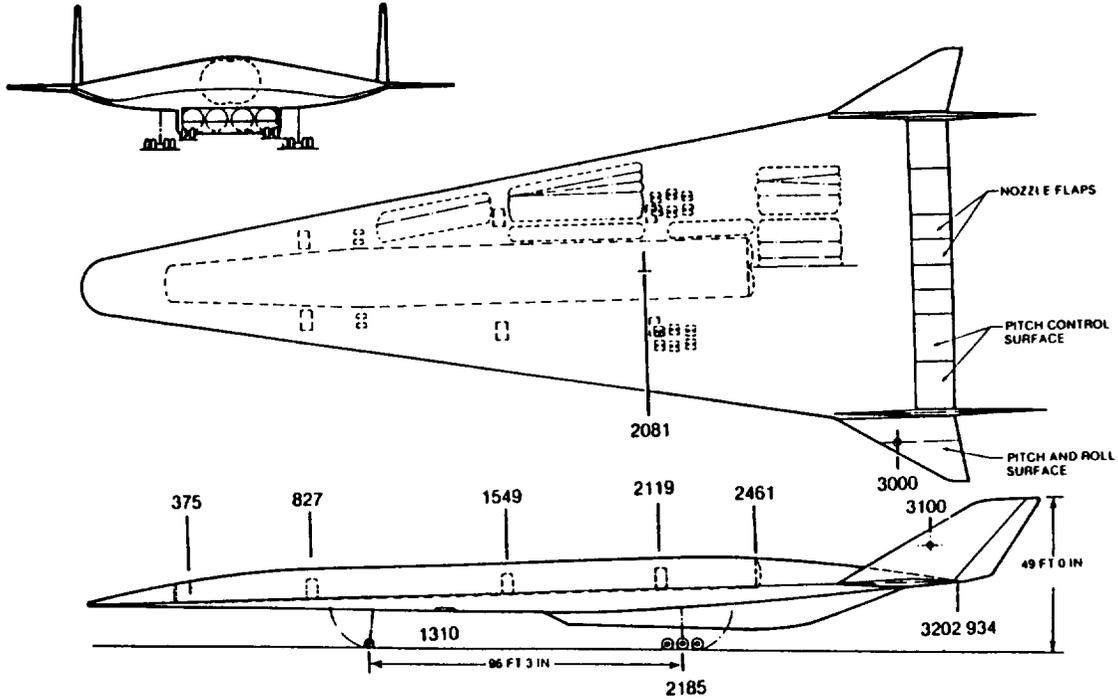


Energy/Matter
Conversion Corp.
Manassas, Virginia

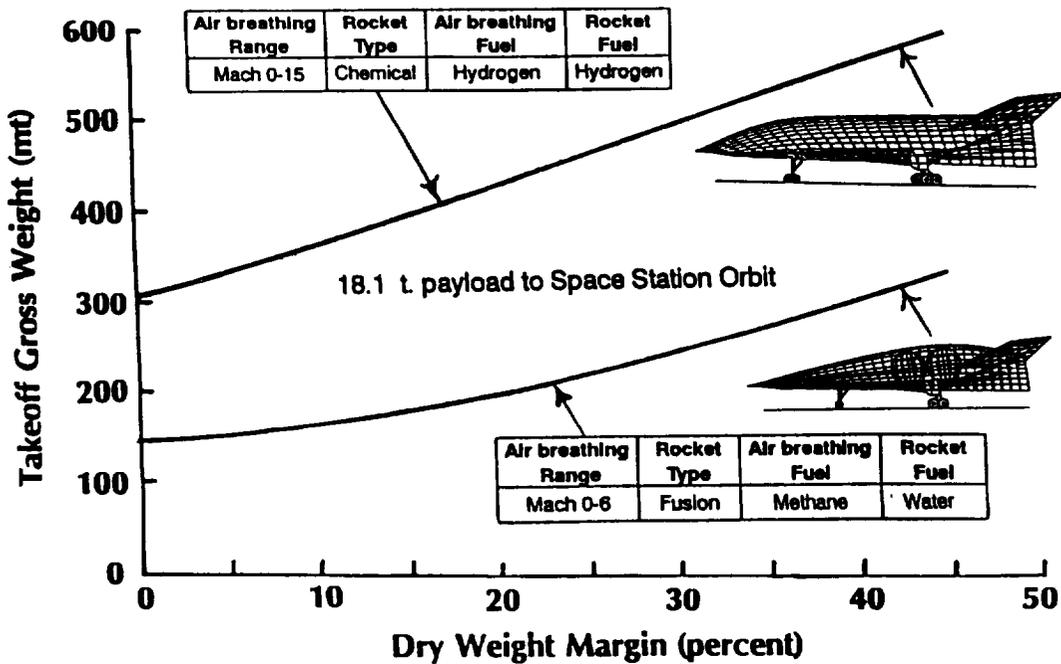


Typical Integration of Subsystems for Fusion-Electric Rocket

A 2 to 3-Fold Reduction in Hypersonic Airliner Mass is Possible if Fusion-Electric Propulsion is Used For the Long Cruise Phase of Flight



Effect of Design Margin on Weight



IAF-92-0569



USE OF PLANETARY ATMOSPHERES FOR CHEMICAL AND FUSION PROPULSION FLIGHT

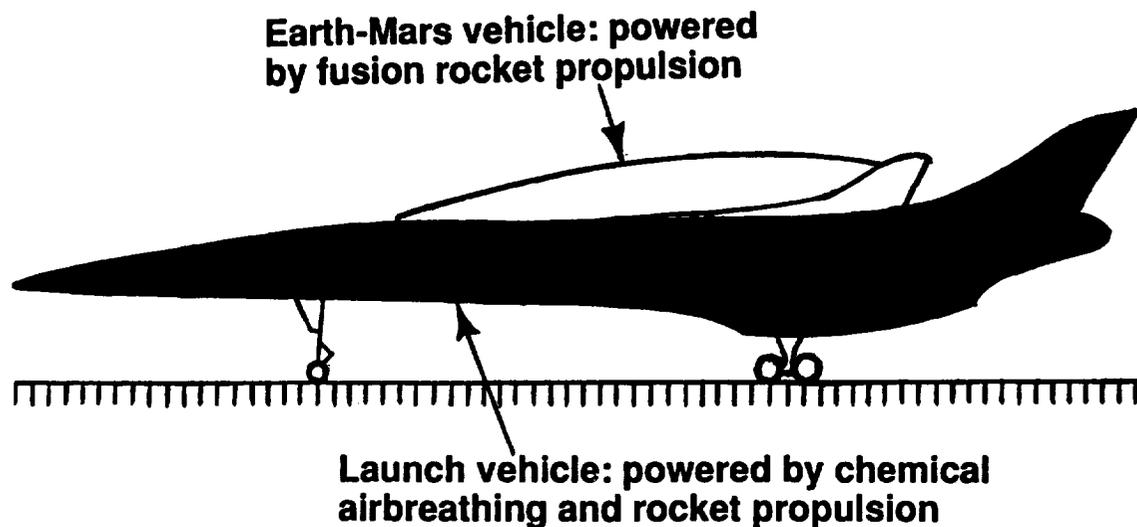
**H.D. Froning Jr.
McDonnell Douglas**

**F.B. Mead
Phillips Laboratory**

**J.L. Leingang
Wright Laboratory**

**S.N.B. Murthy
Purdue University**

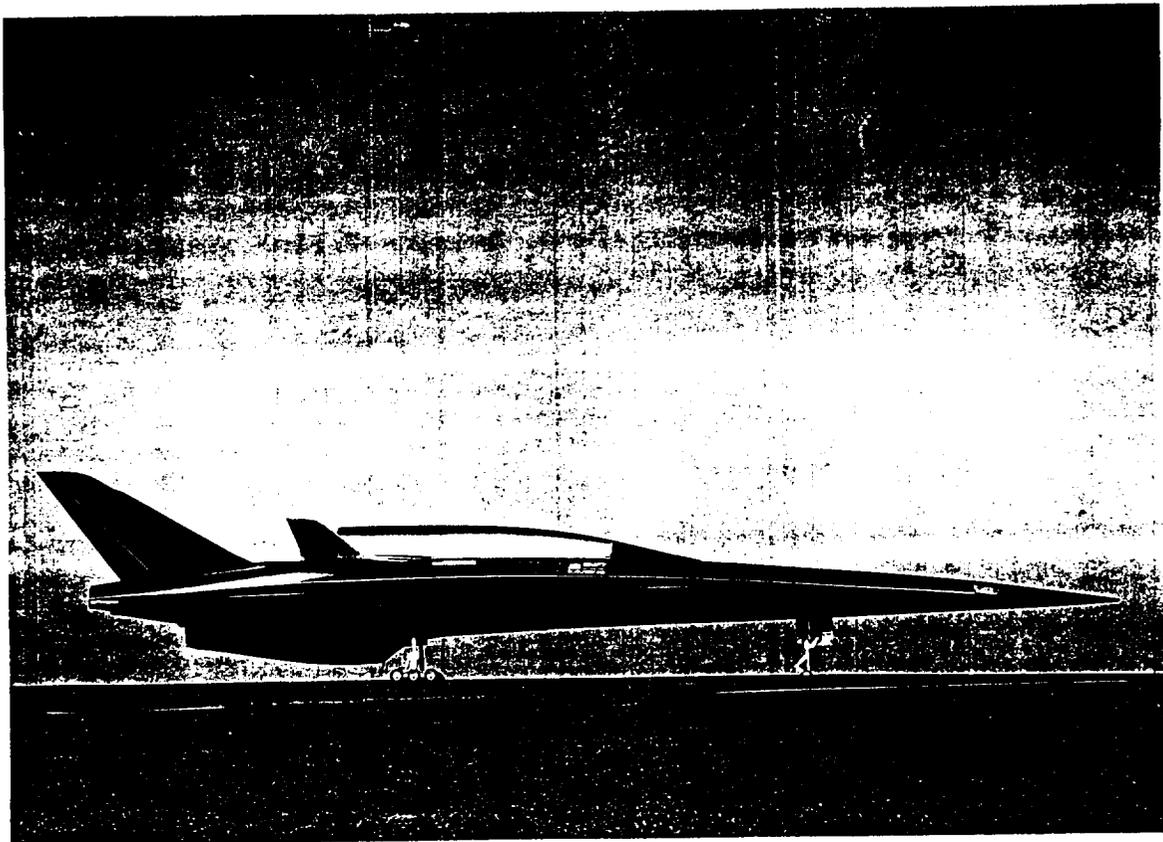
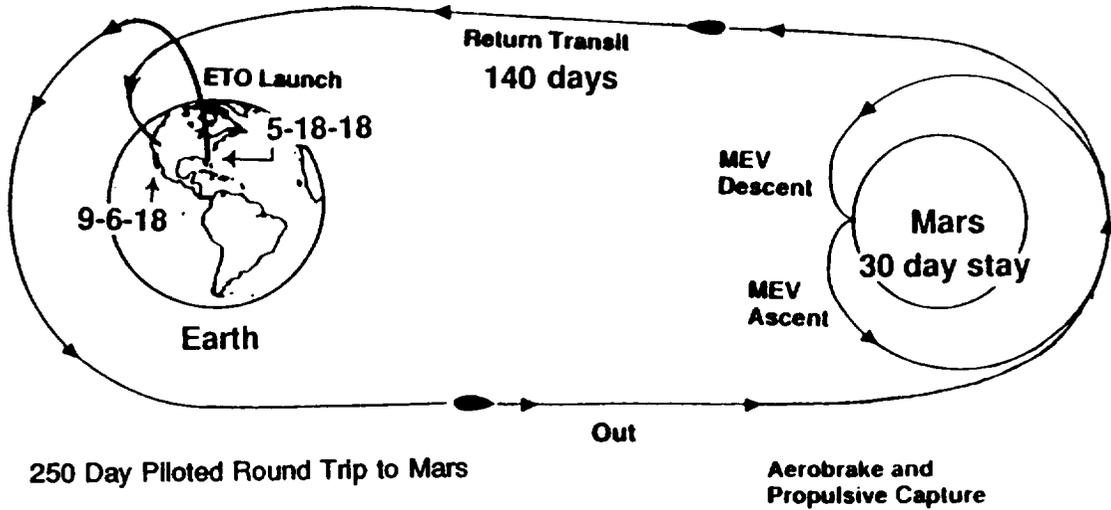
- Oxygen and nitrogen obtained from Earth's atmosphere for propulsion from Earth to Mars**



- Carbon dioxide obtained from Mars's atmosphere for propulsion for return to Earth**

- Habitation Module for Each Trip Leg
- 5-Person Crew

- 25 mt Payload to Mars Surface
- 7 mt Mars Material Returned



A Mars Expedition Takeoff Mass of 2.5 to 5 Million Pounds is Possible – Depending upon the Fusion Propulsion Efficiency Achieved During the Trip

